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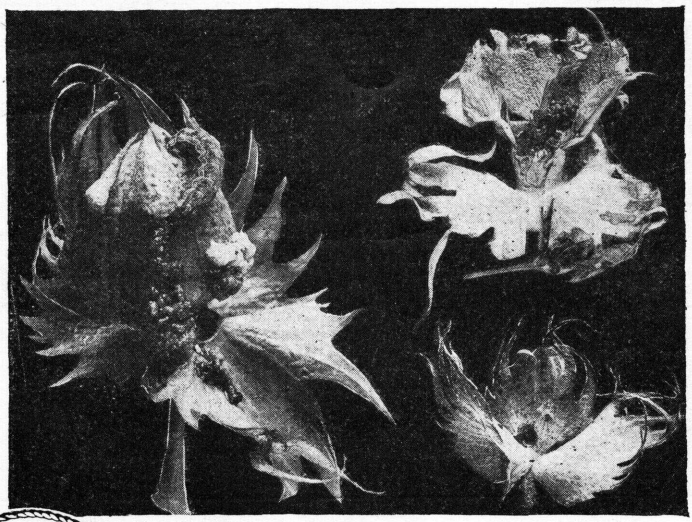
The BOLLWORM OR CORN EAR WORM AS A COTTON PEST



THE BOLLWORM or corn ear worm is an important enemy of cotton, corn, tomatoes, and tobacco. It feeds also on many other cultivated and wild plants.

As the winter is passed in the pupa or resting stage, from 4 to 6 inches below the surface of the soil, late fall or winter plowing will cause the death of many pupae. This is probably the most important of all control practices.

Since the insect increases greatly in numbers late in the season and hard bolls of cotton are largely immune to attack, it is important that the cotton crop be matured as early as possible.

The caterpillar, except when it first hatches from the egg, feeds by boring into the fruit or stalk of the plants attacked; hence poisoning must be done at the right time to give best results. Poisoning of cotton with calcium arsenate, powdered lead arsenate, or Paris green should be done when the ears in the main corn crop become hard; that is, about July 10 to August 20, according to latitude and season.

Corn used as a trap crop gives some protection to cotton. The corn for a trap crop should be planted so as to come into silk and tassel when the ears of the main crop are hardening.

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THE BOLLWORM OR CORN EAR WORM[1] AS A COTTON PEST

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COTTON BOLLWORM, corn ear worm, tomato fruit worm, and false budworm of tobacco are common names applied to one and the same insect when it is found attacking these various crops. In fact, the insect is a very general feeder, attacking many wild plants as well as garden vegetables, alfalfa, cowpeas, and the crops indicated above.[2]

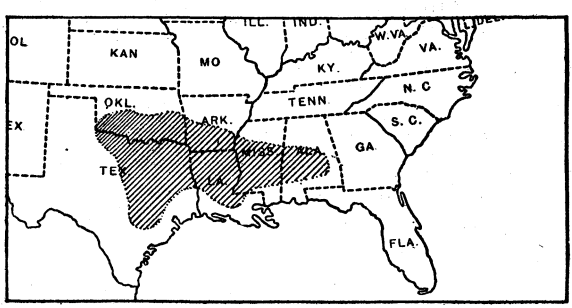

FIGURE 1.—Map showing approximately the area in which the bollworm inflicts severe injury on cotton

This insect should not be confused with the pink bollworm, which is entirely different in habits and appearance.[3]

The bollworm, or corn ear worm as it is most widely known, occurs as a pest in practically all parts of the United States. The corn crop is widely affected, and the loss to this crop, including sweet corn, is enormous. The average annual loss to cotton on account of its depredations has been estimated at $8,500,000. This injury to cotton is most severe in parts of Texas, Oklahoma, and Arkansas. There is also considerable injury in some seasons in Louisiana, Mississippi, and Alabama. (Fig. 1.) Despite these tremendous losses, the fact

[1] Known scientifically as *Heliothis obsoleta* Fab.; order Lepidoptera, family Noctuidae.

[2] For information on this insect as a pest of corn see the following publication: PHILLIPS, W. J., and KING, K. M. THE CORN EARWORM: ITS RAVAGES ON FIELD CORN AND SUGGESTIONS FOR CONTROL. U. S. Dept. Agr. Farmers' Bul. 1310, 18 p., illus. 1923.

[3] For further information regarding the pink bollworm see the following publications: Hunter, W. D. THE PINK BOLLWORM, WITH SPECIAL REFERENCE TO STEPS TAKEN BY THE DEPARTMENT OF AGRICULTURE TO PREVENT ITS ESTABLISHMENT IN THE UNITED STATES. U. S. Dept. Agr. Bul. 1397, 31 p., illus. 1926. OHLENDORF, W. STUDIES OF THE PINK BOLLWORM IN MEXICO. U. S. Dept. Agr. Bul. 1374, 64 p., illus. 1926.

that the insect has been present as a pest in this country for many years has caused most farmers to become tolerant of it.

FIGURE 2.—Young corn plant showing bollworm injury to growing tip. (Quaintance)

CHARACTER OF INJURY

The character of attack on all the principal crops affected is similar. Where the type of plant growth will permit, the caterpillars usually bore into and feed within the plant tissue. The first damage

to corn is caused by boring into the bud and eating down into the tender leaves as they unfold. (Fig. 2.) A little later this injury often seriously affects the tassels before they have opened out, and when the silks appear eggs are laid upon them, and young corn ear

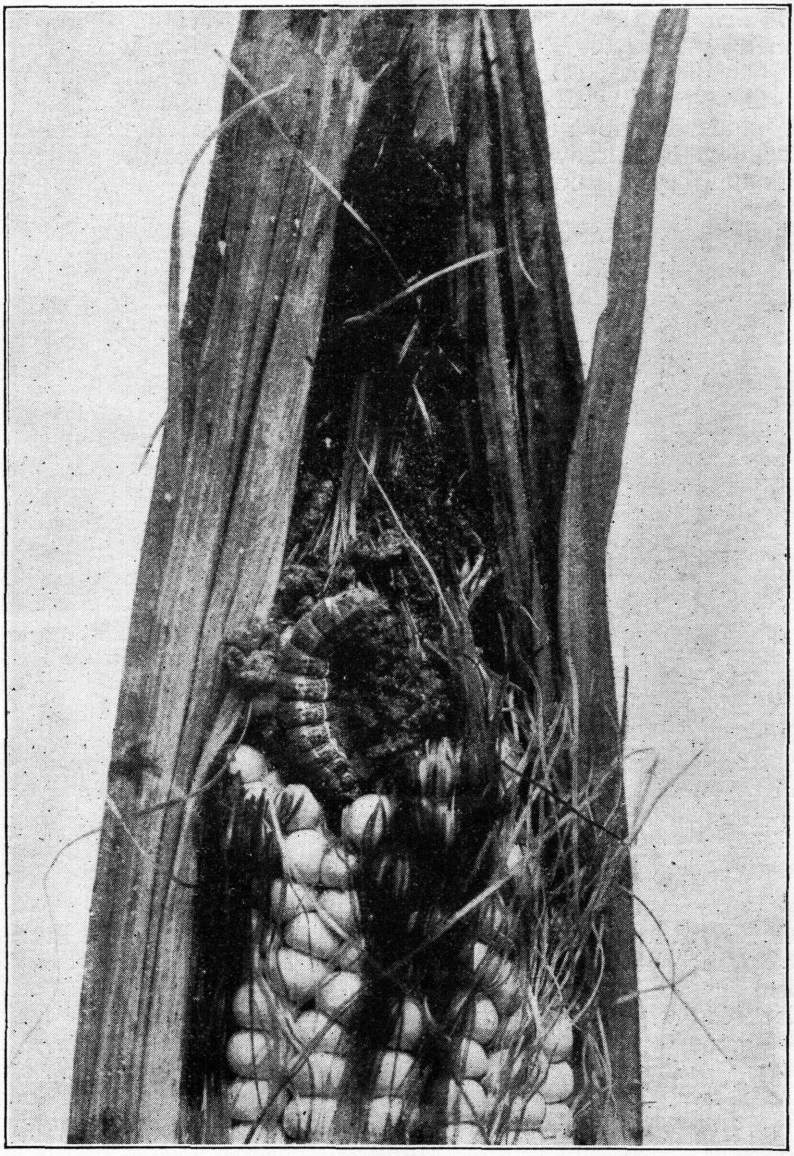

FIGURE 3.—Bollworm and its injury to an ear of field corn. (Quaintance and Brues)

worms burrow down through the silks and attack the small kernels, as shown in Figure 3. The tips of the ears are injured first; later, especially in tender varieties such as sweet corn, the worms sometimes eat completely to the base of the ear and almost destroy it. In some

regions practically every ear of sweet corn is more or less damaged, and in the cotton States from 70 to 98 per cent of the ears of field corn are attacked.

In the case of cotton the injury is readily distinguished from that caused by the boll weevil (fig. 4), as the squares and more tender bolls are completely eaten out, particularly after the worms have gained considerable size. Occasionally full-grown bolls are gnawed into by the large caterpillars and from one to all of the locks of cotton damaged. (Figs. 5, 6, and 7.) Bolls which have become hard are seldom fed upon to any extent, although the worms, when abundant, have been known to gnaw around the bases of the full-grown bolls and finally to cut off the supporting stems.

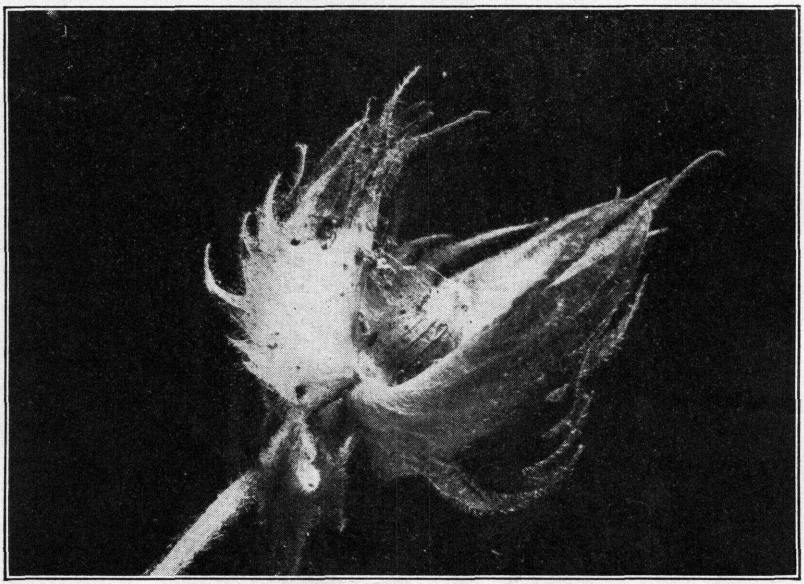

FIGURE 4.—Cotton square partly eaten out by young bollworms. Note web which is evidence of the presence of young bollworms. (Quaintance and Brues)

HABITS OF THE INSECT AND HOW IT DEVELOPS

A general knowledge of the life history and habits of an insect is needed in order to combat it intelligently. The adult of the bollworm or corn ear worm is a moth or miller about 1⅓ inches across the spread wings (fig. 8), ranging in color from a light brown or olive green to pale yellow. It is commonly seen flying about in the evening, and feeds upon nectar of various flowers. When mature a female may deposit from about 500 to almost 3,000 eggs. The eggs are laid on various parts of the plant and to some extent upon weeds and upon the ground. Observations on the distribution of the eggs on the cotton plant show that only 20 to 40 per cent of them are laid on the squares, blooms, bolls, and tender growing tips. They are white or yellowish, oval, and covered with minute ridges running from top to bottom and still smaller ridges across these. (Fig. 9.) They are large enough to be seen readily with the naked eye. The

eggs hatch in from two and one-half to eight days, or the period may be even longer, depending upon the temperature.

When first hatched the larvae or caterpillars are extremely small. They feed here and there on the surface of the plant near where the eggs were laid, but gradually work toward some tender portion within which they can bore. Growth varies with the food supply and temperature, the period ranging from 12 to 70 days. The larvae shed their skins four or five times during this period. When full grown they are about 1½ inches in length. The color varies from

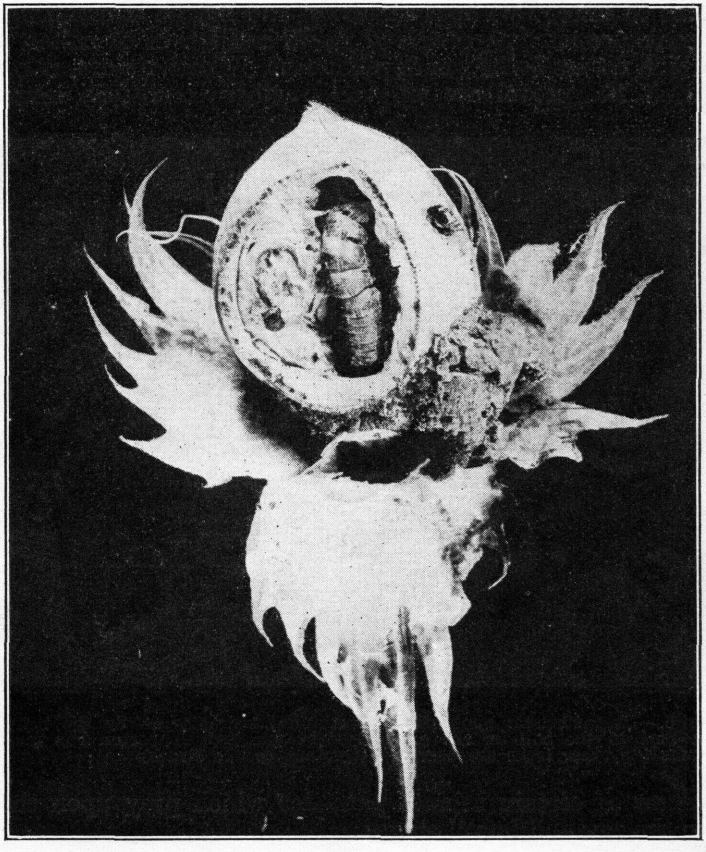

FIGURE 5.—Full-grown bollworm and its work in a large cotton boll. Slightly enlarged. (Quaintance and Brues)

pale green to almost black. During the last few days of active feeding the caterpillar is capable of consuming large quantities of food, and it is during this period that it is most destructive.

When fully fed, the larvae leave the plants and burrow into the ground, where they form cells in which they transform into chrysalids or pupae of a mahogany-brown color. (Fig. 10.) They remain in this quiescent stage for about two weeks, except in the case of the last brood in the fall, which stays in the ground until warm weather the following spring. The depth at which these cells are

formed by the larvae in summer ranges from 1 to 4 inches according to the hardness of the soil. The overwintering pupae are formed at somewhat greater depths, usually from 4 to 6 inches. These chrysalids or pupae produce moths which in turn lay eggs. The life cycle may be completed in as short a period as 30 days in warm weather.

That there is a definite connection between weather conditions and injury to the cotton crop by this insect is generally recognized. Cloudy and rainy weather during the latter part of July and throughout August undoubtedly is conducive to severe injury. This is partially explained by the moistening of the soil, which permits the moths to emerge without difficulty, and by the stimulating effect of the moisture on the growth of stalks and leaves of cotton at this time, which favors bollworm development. Furthermore, it has been found that the prevalence of such weather conditions lessens the

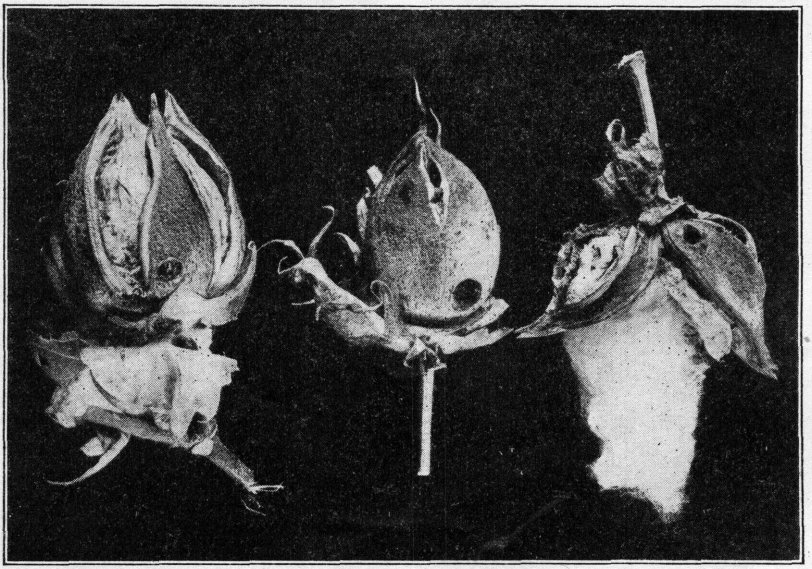

FIGURE 6.—Characteristic appearance of cotton bolls damaged by the bollworm. Note that in the boll on the extreme right one lock of cotton has matured, whereas the other locks are barren. (Quaintance and Brues)

effectiveness of certain minute parasites which prey upon the bollworm in the egg and larval stages.

SEASONAL HISTORY AND RELATION OF ABUNDANCE TO CROP GROWTH

As has been stated, the bollworm, or corn ear worm, pupa passes the winter months in the soil in the cotton States. Early in the spring the moths begin to come out, and by the time corn is knee-high they are ready to deposit eggs. On account of the number of pupae which die from adverse conditions in the winter, the first generation usually is small, and the damage is not so appreciable. The second generation appears about the time the corn is in silk and tassel, and the number of moths is greatly increased. The caterpillars of that generation reach their full development about the

time the ears of early corn become hard. In the South the third generation is the one which is destructive to cotton, the corn at that time being for the most part hard and dry. In that region four, or even five, generations may develop during a year. The late caterpillars feed on various green crops, including late cotton, cowpeas, and alfalfa. Thus in the Southern States most of the overwintering insects will be found in soil where cotton and other late-growing crops are raised.

The bollworm shows a preference for corn when the corn is silking, and this fact can be utilized to some extent in protecting cotton and other crops from injury, as will be pointed out later. These caterpillars are cannibalistic, and when they come in contact with one another many of them are killed, which usually reduces the number of worms developing in a single ear to one, two, or at most three, whereas dozens of eggs may be laid upon a single strand of corn silk.

FIGURE 7.—Full-grown bollworm eating into the tip of a cotton boll. Natural size. (Quaintance and Brues)

CONTROL MEASURES

As a result of the study of the life history and the seasonal history of this insect it will be seen that there are four outstanding facts which can be made use of in control work: (1) The insects spend the winter in the pupal stage in the ground. The summer generations also spend some time (about two weeks) in the pupal stage in the ground. This enables the farmer to destroy many of them by plowing at the proper time. (2) The caterpillars feed for a time on the surface of the leaves before penetrating the tissues of the plant. This is the only time during which the insect can be poisoned successfully. (3) The number of bollworms or ear worms increases greatly as the season advances. This indicates a need for hastening the maturity of all crops affected. (4) Since green corn is preferred as food, it is possible to utilize this to some extent as a trap crop to protect cotton and other crops.

It has been found that by modifying slightly the usual farm practices much can be done toward lessening bollworm or corn ear worm injury. Fortunately these modifications are such as to increase crop

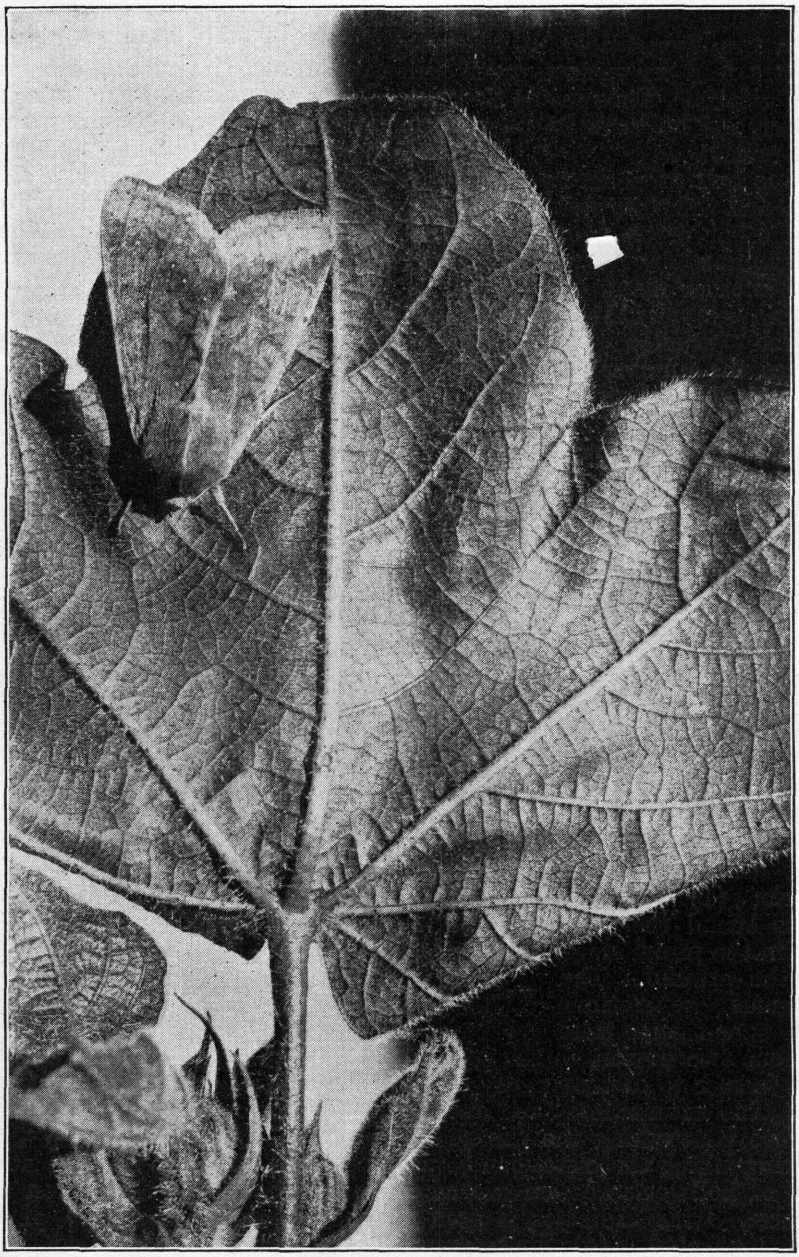

FIGURE 8.—Bollworm moth at rest on cotton leaf. About twice natural size. (Quaintance and Brues)

production, regardless of the presence of this insect. Another important point is that some of the recommendations for controlling this insect are equally applicable, irrespective of the crop grown.

FALL AND WINTER PLOWING

Probably the most important single step in controlling the bollworm consists in the thorough breaking, at some time during the late fall or winter months, of the land in which the worms have buried themselves for the winter. Particular attention should be paid in this respect to land that has been in crops which are known to harbor bollworms during the late fall months. The practice of fall and winter plowing, aside from bollworm control, is desirable because it conserves moisture, puts the ground in better condition for planting, and enables the farmer to plant at the proper time the following spring.

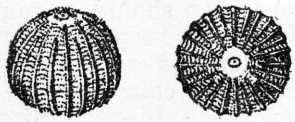

FIGURE 9.—Egg of bollworm moth, side and top views. Enlarged 30 diameters. (Quaintance and Brues)

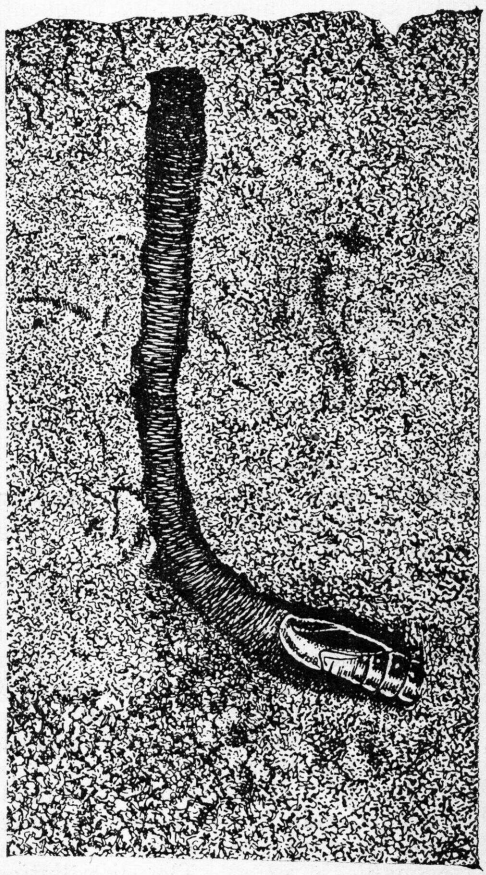

FIGURE 10.—Vertical section through soil, showing pupa of bollworm in its burrow. About natural size. (Redrawn from Quaintance and Brues)

It has been found that the breaking up of the cells in which the insects are spending the winter results in the destruction of practically every pupa through the action of cold and moisture. Since the cells of the wintering brood are formed at from 4 to 6 inches beneath the surface, it is important that the plowing be deep enough to reach them. It is desirable to plow or deeply disk the fence rows and other places where bollworms may have fed on various plants. This is also beneficial in destroying eggs of grasshoppers and the hibernating places of chinch bugs and other destructive insects.

CONTROL BY CULTURAL PRACTICES

Several of the measures best calculated to reduce bollworm injury in the cotton-growing States are equally effective in checking

the ravages of the boll weevil. No loss of money or energy results from putting such cultural practices into effect, even though the bollworm should not appear in very destructive numbers in any particular year.

To protect cotton from bollworm injury it is important (1) that seed of early-maturing cotton be selected; (2) that the crop be planted as early as is consistent with getting a good stand and having the crop start off well; (3) that poor lands be fertilized and cultivation be thorough and frequent. Every step should be taken which will hasten the early maturity of fruit and keep the plants in a healthy, growing condition. The reason for this can be readily seen since we know that the bollworms pass to the cotton when the corn becomes mature, and that hard bolls are less subject to injury. As the moths hide in the foliage when the growth is luxuriant, those varieties which make comparatively small stalk without a superabundance of leaves are desirable. This also hastens the drying out of the bolls after they are grown. The early and complete destruction of cotton stalks, as recommended for boll-weevil control, will prevent the maturity of many late bollworms and destroy a considerable number outright.

The growing of all corn in a single block, rather than scattering it over the plantation, is advised.

PROTECTION OF COTTON FIELDS BY POISONING BOLLWORMS IN OTHER CROPS

When bollworms are found to be present in large numbers on alfalfa, vetch, or cowpeas before cotton is well matured, poisoned bran mash may be used to advantage. This is made as follows: Wheat bran, 50 pounds; Paris green or white arsenic, 1 pound (or powdered calcium arsenate, 2 pounds); low-grade molasses, 2 gallons; water, 3 to 4 gallons. The bran and insecticide are first mixed together dry, the molasses and water are then added, and the whole mass is thoroughly mixed. The mash should be broadcast thinly over the fields. An application of 10 pounds of bait per acre is ample. It is preferable to scatter the bait late in the evening.

Calcium arsenate applied as a dust to such infested fields is also effective, and there is no danger of poisoning stock if only one application of 5 pounds per acre is made and if the forage is exposed to a good rain before being harvested. The standard calcium arsenate as used against the boll weevil is generally available and reasonable in price. The distribution should be thorough. There are a number of standard types of cotton-dusting machines on the market, and any of these may be used for making the application. For large areas the employment of an airplane properly equipped as for dusting cotton may be advisable.

POISONING COTTON

The use of poisons against the bollworm has met with considerable success where the poisons have been applied at the proper time. Dusting cotton with calcium arsenate is now a standard control measure for the cotton boll weevil. Where the boll weevil and bollworm occur in destructive numbers in the same fields the two insects may be combatted simultaneously by this method.

Attention has been directed to the fact that a large proportion (from 60 to 80 per cent) of the eggs of the bollworm deposited on cotton are placed elsewhere than on the squares, flowers, and growing tips. Following hatching, therefore, it is necessary for the young larvae to travel a considerable distance before penetrating the fruit. During this rather aimless wandering the insect eats here and there from the surface of the leaves and stalks. Throughout this short period in the existence of the larva it may be poisoned by eating some of the insecticide.

The importance is emphasized of getting the poison on the plants when the numerous young larvae of the August generation begin to hatch and not after the larvae have grown to considerable size. In the later stages they have burrowed into the squares and bolls and are not feeding on the surface where the poison has been deposited.

The time for applying the poison to cotton varies slightly from year to year. The first application should be made when the corn ears are becoming hard. The actual date will range from about July 10 to August 20, according to latitude and seasonal conditions. Close examination of the cotton plants at this time will show the earliest-hatched bollworms making minute holes in squares. Often their presence may be detected by the delicate webs which the young worms sometimes spin about the squares.

Calcium arsenate, powdered lead arsenate, or Paris green may be used for poisoning, but since the department is advocating the use of calcium arsenate against the boll weevil, and since that product is being prepared especially by chemical companies for use on cotton, it is readily available and has an advantage over Paris green in not burning the cotton plants and in being less dangerous to apply. It is more poisonous to insects than lead arsenate and is much cheaper. However, during recent years several instances have been noted in which severe bollworm injury developed on cotton which had been poisoned sufficiently for boll-weevil control. In some cases this was evidently due to the fact that dusting ceased before the bollworm migrated to the cotton, but in others some other explanation is needed, and this problem is the subject of a special investigation now being conducted by the Bureau of Entomology.

While it is possible to apply poison to cotton in the form of a spray (Paris green 1 pound, water 50 gallons), this method is usually impractical, and dust applications are advised. If Paris green is used it is best to mix it thoroughly with some carrier, such as air-slaked lime in the proportion of 1 pound of Paris green to 3 pounds of the carrier, and make application at the rate of from 6 to 9 pounds of the mixture per acre, according to the size of the plants.

If calcium arsenate is used, a standard cotton-dusting grade, such as is sold for boll-weevil control throughout the South, should be obtained, and it should be applied, without any other substance added, at the rate of from 4 to 5 pounds per acre. This is a very light fluffy powder which forms an excellent dust if blown on the cotton with force.

The method of application should depend on the acreage to be treated. For poisoning small areas up to about 25 acres hand dust guns, which are on the market, may be used. About 3 acres a day

can be covered by one of these. For larger acreages wheel-traction dusters (fig. 11) are obtainable, and for very large areas power dusters may be advisable.[4]

Some may prefer the old-fashioned method of applying poison with a bag and pole. This method lacks thoroughness and, while satisfactory for controlling the leaf worm, it does not give best results against the bollworm. This equipment may be carried across the back of a mule, the poison being jarred out through the bags by movements of the animal and by tapping the pole. The construction of one of these outfits is very simple. Rectangular cloth bags are nailed to either end of a 4-inch board of a length equal to the distance between two cotton rows, as is shown in Figure 12. For dusting with Paris green 8-ounce duck should be used, and for calcium arsenate domestic is satisfactory.

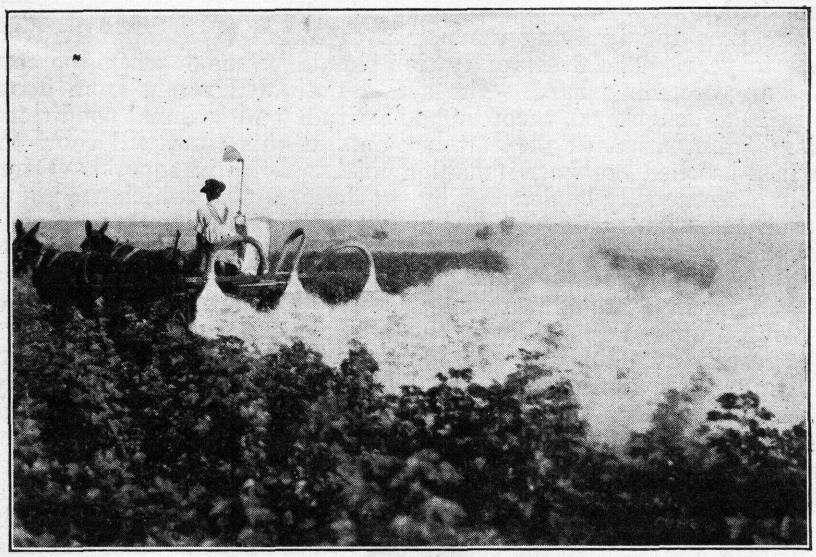

FIGURE 11.—A wheel-traction duster distributing calcium arsenate on cotton plants for the control of the bollworm

To get best results the dusting should be done when the plants are covered with dew. This usually necessitates making the application during the night or in the early morning hours. Windy periods should be avoided.

It should be remembered that all of these arsenicals are poisonous to man and animals, although they are not dangerous if properly handled. Calcium arsenate is less injurious to man than Paris green. Men employed in distributing the poison should change their clothes and bathe immediately after ceasing work. No case of poisoning of animals used in drawing the machines has been observed, but if they are inclined to eat the cotton plants it is best to safeguard them by using muzzles.

[4] For discussion of dusting machinery for boll-weevil control see the following publications: JOHNSON, E., HOWARD, S. T., and COAD, B. R. COTTON-DUSTING MACHINERY. U. S. Dept. Agr. Farmers' Bul. 1319, 20 p., illus. 1923. COAD, B. R., JOHNSON, E., and MCNEIL, G. L. DUSTING COTTON FROM AIRPLANES. U. S. Dept. Agr. Bul. 1204, 40 p., illus. 1924.

The number of applications should depend largely on the abundance of eggs deposited during the few weeks following the first application. Some years the bollworms appear in great numbers at one time, but in other seasons they are more or less distributed through the late summer. On the average it is believed that two applications of poison 7 to 10 days apart will give the best results. If a heavy rain should follow within 24 hours after an application another treatment should be given. After the poison is well dried on with the dew it will withstand considerable rain.

In rather extensive experiments in the use of Paris green against the bollworm, the use of the poison resulted in a gain per acre of $5.21 over the return from undusted fields, even after the cost of the poison and the expense of application had been deducted. Some of the fields were treated once and others received two applications.

Although the approved method of using poison dust for control of the bollworm is somewhat different from that for control of the boll weevil, a high degree of control of the bollworm should ordinarily result in sections where poisoning of the boll weevil [5] is practiced. Where the boll weevil and bollworm are both frequently numerous an attempt should be made to follow the infestations in the fields closely enough to make applications of the poison at the proper time to check the ravages of both of these pests.

In most districts, on account of the sporadic occurrence of bollworms in great numbers, it is rather difficult to foresee just when

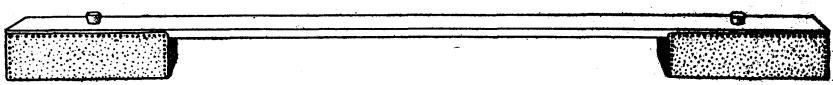

FIGURE 12.—Bag and pole for use in distributing poison in bollworm control

serious injury will occur, but it would no doubt be profitable to apply poison each year in the portions of Texas and Oklahoma where bollworm damage is general and more severe.

CORN AS A TRAP CROP TO PROTECT COTTON

Since the bollworm prefers corn to cotton or most other plants for food, it is possible to concentrate the larvae on corn and keep them from becoming so numerous on cotton. To effect such a result, it is important that the trap corn be planted at such a time as to be in silk and tassel about the time the main crop of field corn becomes hard, which is usually near the first of August. If it matures too early, it will act only as a breeding place for bollworms, which will mature as the ears harden and a short time later transform to moths which in turn will deposit eggs over adjacent cotton fields. On the other hand, if the plants are in an attractive state, the moths, which fly quite freely, will assemble in the corn from considerable distances and deposit most of their eggs on the corn plants. These eggs will hatch and the young larvae, being so numerous, will destroy one another to such an extent that usually not more than a few out of the many hatching on the silk of each ear will reach maturity.

[5] The poisoning of the boll weevil is discussed in the following publications: COAD, B. R., and GAINES, R. C. POISONING THE COTTON BOLL WEEVIL. U. S. Dept. Agr. Leaflet. No. 37, 4 p. 1929. HUNTER, W. D., and COAD, B. R. THE BOLL-WEEVIL PROBLEM. U. S. Dept. Agr. Farmers' Bul. 1329, 30 p., illus. 1923.

One plan of planting the trap rows consists of leaving belts from 10 to 40 feet wide across the field at the time the cotton is planted and about June 1 planting this space with Mexican June corn in rows 5 or 6 feet apart. About 10 days later a row of cowpeas may be planted between the corn rows, room thus being left for cultivation and at the same time furnishing attractive places for the bollworm moths, which will concentrate in the trap rows in great numbers.

Another system is to plant larger patches of June corn and cowpeas here and there over the plantation, following such crops as oats, wheat, and potatoes. This has some advantage over the plan just outlined, as the larger areas of corn appear to permit less egg laying on the adjacent cotton than where narrow strips are used, and in addition the land is more fully utilized. As far as possible the trap crop should be located between the early corn and the cotton.

Either of these systems provides a trap crop for the bollworm, and often makes possible a good yield of corn and a crop of cowpeas which is valuable as green manure or for food and forage. While any variety of corn may be used, the Mexican June corn is more desirable in the Southwest on account of its resistance to drought.

INEFFECTIVE METHODS OF CONTROL

The burning of lights to attract the moths in the fields is not uncommon in certain sections, and the idea of trapping the moths by various devices is often advocated. Both of these methods have been tested thoroughly and have been found to be of little or no value. In the first place, most of the moths caught are males, or females which have deposited their full quota of eggs, and in the second place a great many beneficial insects which prey upon the bollworm in different stages are destroyed. The placing of poisoned sweets in pans in the cotton field also has been found to be a useless practice.

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